Space Weather Technical Forecast

Issued on Tuesday, 22 August 2023 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing chance of M-flares (R1-R2 Radio Blackouts). Slight chance G1 Minor Storms late day 2 or day 3 (23-24 Aug).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with peak flare C5.7 at 22/0000 UTC from the new region rotating onto the disc in the east. There are eight numbered and two unnumbered sunspot regions on the disc, however these are generally small and simple. The most notable numbered region is AR3413 in the northeast, however this appears to be a relatively simple bipolar group dominated by a main leader, despite some complexity due to opposite polarity small spots to the north and southeast of the leader. Of the numbered regions, this produced the largest flare, a C4.7 at 21/2343 UTC. The main region of interest is the new region rotating onto the east limb. This is currently at too oblique an angle to accurately assess, however it is clearly already evident in intensity imagery, suggestive of a strong active region. Further details are likely to become apparent over the next 24-48 hours, including any magnetic complexity.

A filament eruption was observed leaving the southwest disc at 21/1613 UTC, and a weak CME has been identified in the very limited SOHO LASCO imagery that is available. Confidence is very low, however at most a weak glancing interaction is possible later in the period. However further assessment is still being undertaken.

Solar Wind / Geomagnetic Activity: The recent fast wind, from an unnumbered coronal hole, eased through the period. Solar wind speeds measured by DSCOVR eased from elevated to be slightly elevated (around 550km/s to 460km/s). Density rose from below to near average. Total Interplanetary Magnetic Field (IMF) Bt, was weak, below 5nT, with the north-south component, Bz, initially mainly positive (northward) and peaking 4nT, but more generally negative (southward) from 22/0015 UTC with minimum -4 nT. Geomagnetic activity was Quiet to Unsettled (Kp1-3)

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background. GOES16 high energy (greater than 2MeV) electron flux ranged from Background to Moderate. The associated 24-hour fluence was well below the Active level, with an observed value of 4.83e6 integrated pfu at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be Low, but with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs, however the filament eruption leaving the disc on 21 Aug may give a very slight glance towards the end of the period. This is still under analysis however. Current fast winds are expected to gradually and erratically ease day 1 and into day 2 (22-23 Aug), before the arrival of the next fast wind enhancement, most from CH39/+ in the southeast. This is a low confidence feature however, with current models not incorporating it and the previous rotation contaminated with a CME arrival. However, enhancement is most likely late day 2 or day 3 (23-24 Aug), with solar winds potentially rising again to around 500-550km/s. Mainly Quiet geomagnetic activity at first, with isolated Unsettled

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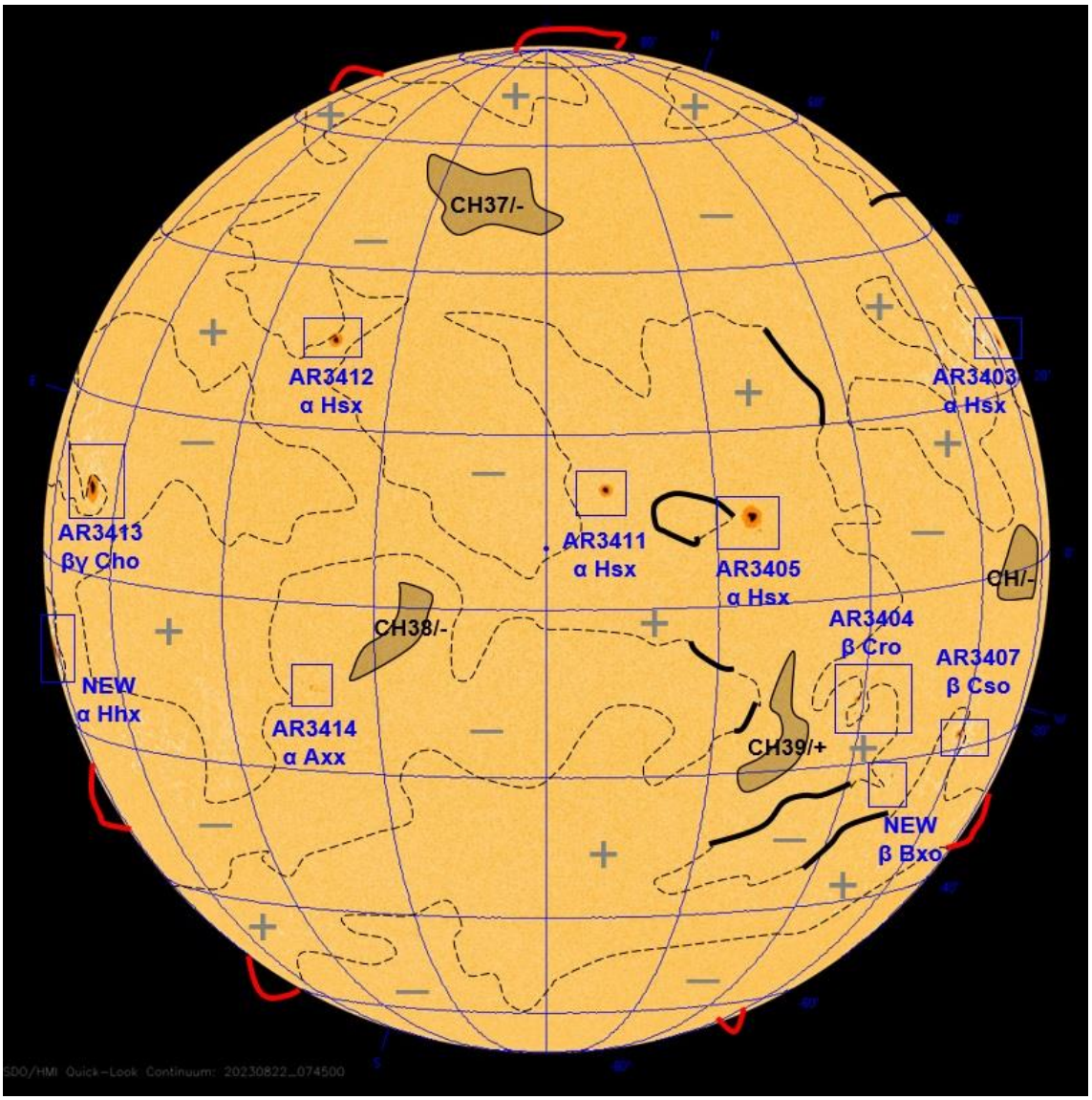
spells. There is a slight chance of Active intervals day 1 (22 Aug), but more likely later day 2 and day 3 (23-24 Aug). There is a slight chance of isolated G1 Minor Storms with any arrival. Activity is expected to ease back to be mostly Quiet to Unsettled day 4 (25 Aug)

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) will vary from Background to Moderate day 1-2 (22-23 Aug) before a subsequent drop out is expected from any fast wind arrival late day 2 or day 3 (23-24 Aug). Flux is then likely to increase again day 4 (24 Aug) as any enhanced solar winds ease. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 22/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs, however a filament eruption from the vicinity of AR3404 was observed around 21/1615 UTC, and is still undergoing assessment. Available imagery for analysis is very limited, however current suggests are for a glancing influence at most from this, towards the end of the period.

Recent fast wind enhancement is now easing, with the next most likely source of any increase in speed to be from any interaction with CH39/+. This is a small positive hole in the southwest disc, but due to nearby active regions contaminating imagery of the feature, is uncertain in extent. Furthermore, very little enhancement is indicated in Enlil, however this failed to detect the previous increase that occurred. 27-day Persistence is also contaminated from a CME arrival, so despite the coronal hole being present on the previous rotation, this also provides little guidance. Overall, this leads to low confidence in the forecast, however an enhancement to around 500-550 km/s is currently considered possible, most likely later day 2 or day 3 (23-24 Aug)

Mainly Quiet geomagnetic activity expected at first, with isolated Unsettled spells. There is a slight chance of Active intervals day 1 (22 Aug), but more likely later day 2 and day 3 (23-24 Aug) from any fast wind arrival from CH39/+. Due to the Russel-Mcpherron effect, increasing the geoeffectiveness of positive coronal holes at this time of year, there is a slight chance of isolated G1 Minor Storms with any arrival. Activity is expected to ease back to be mostly Quiet to Unsettled day 4 (25 Aug).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2a: SDO aia-193 (left) and aia-211 (right) showing coronal holes in SE, SW and NE

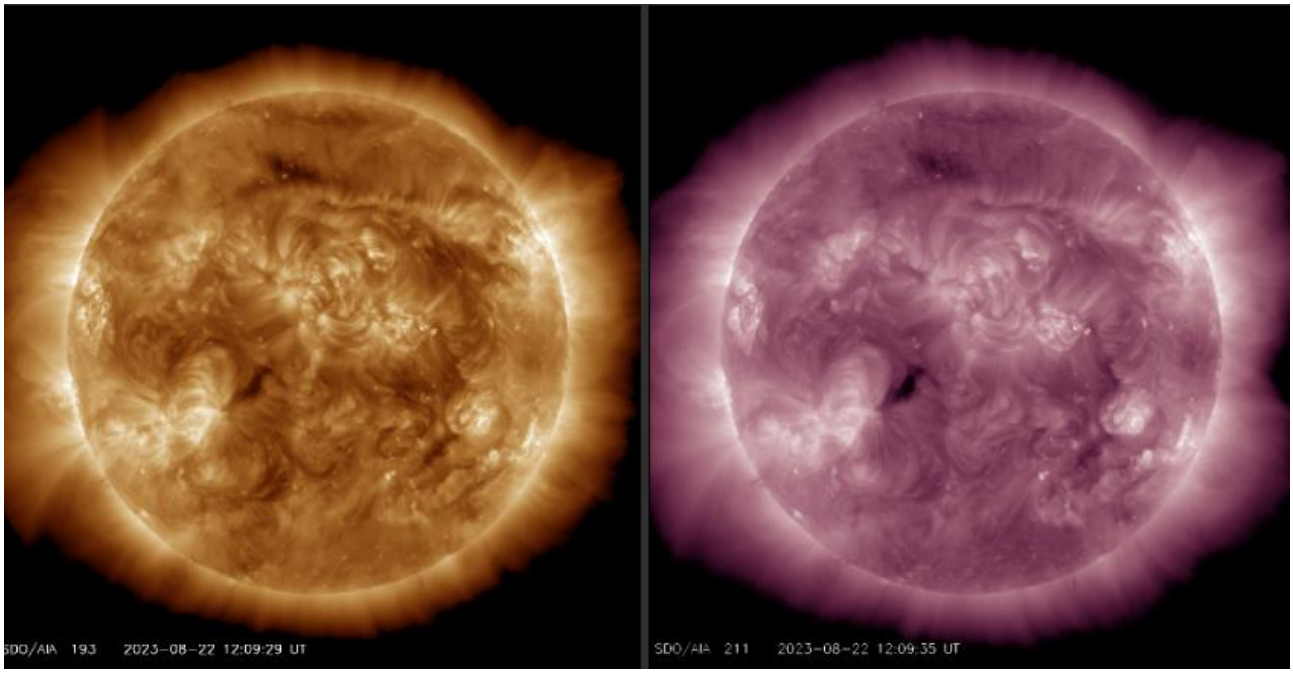
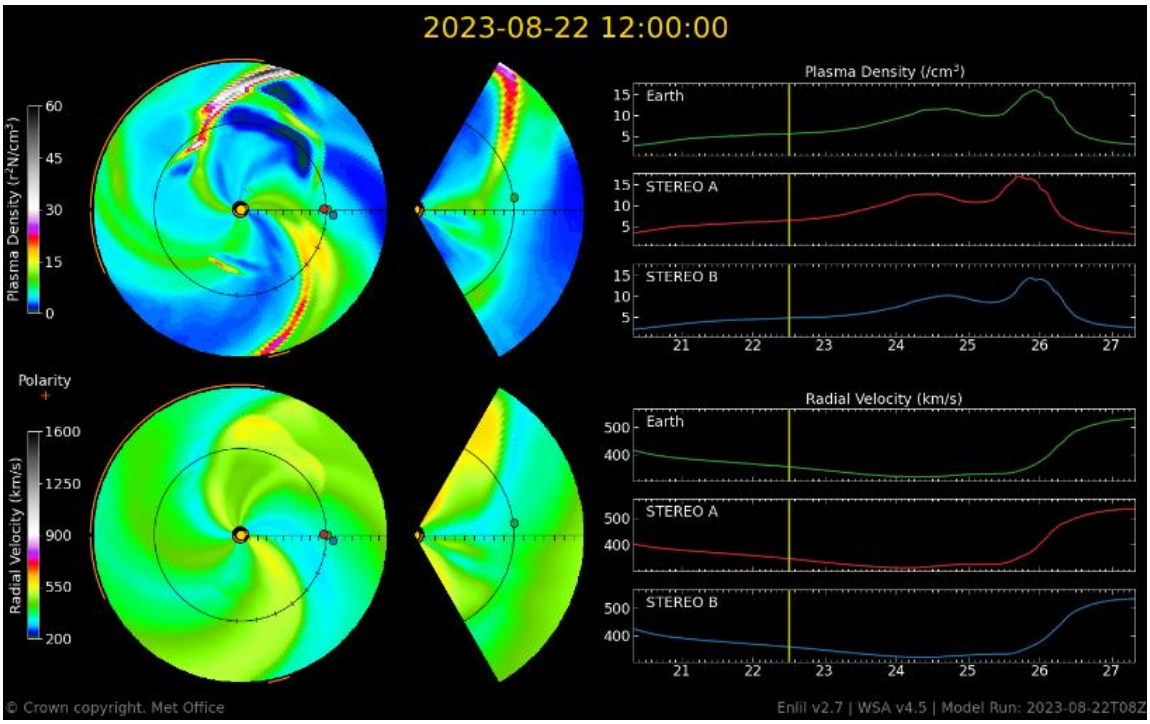


Figure 2b: Enlil with no notable coronal hole enhancement.



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Radio Blackouts - X-Ray Flares:

Low activity expected, but with a chance of increasing to Moderate from isolated M-class flares. There are currently eight numbered regions on the disc, however these are either small and simple or stable mature unipolar spots, with only a slight chance of M-flares. No significant development of any of these regions has been observed. The predominant flare risk is from a new spot that is rotating onto the disc. This is difficult to assess, due to being on the east limb, however it is already visible on SDO intensitygram imagery, suggestive of a strong active region. As this moves into a less oblique viewing angle any complexity will become increasingly apparent. This region also corresponds to a large region that could be identified on the far-side a couple of days ago based upon available online imagery from the Mars Perseverance rover and helioseismic signals of far-sided products (e.g. from jsoc.stanford.edu).

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	30	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3a: GOES 16/18 X-ray Flux

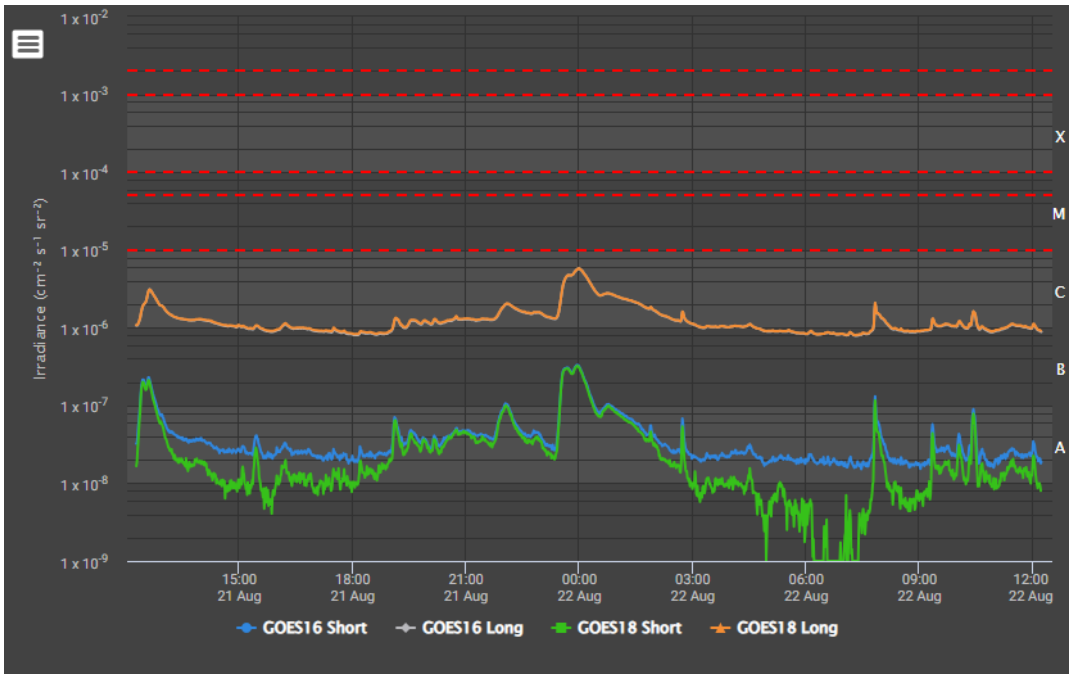

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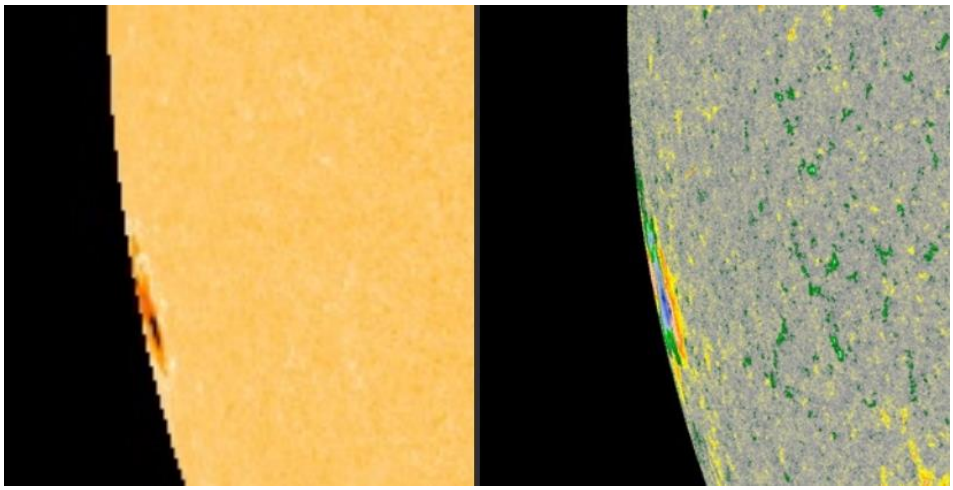
Figure 3b: SDO intensitygram and Magnetogram of new region on E-limb



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at Background levels, with the spots on the western disc currently small and simple.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES-16 is currently varying between Background and Moderate, due to recent fast wind arrival. However, due to the lack of notable geomagnetic activity with this enhancement, the influx of electrons into the Van Allen belts is currently expected to be limited, with peak flux persisting at Moderate, perhaps just briefly reaching High levels day 1 and day 2 (22-23 Aug). Any further solar wind enhancement day 2-3 (23-24 Aug) will then likely drop out observed flux to background, before a more increase to Moderate, perhaps High levels day 4 (25 Aug), as solar winds ease.

The associated 24 hour fluence is expected to persist below the Active level, with no significant enhancements expected. An increasing trend is expected day 4 (25 Aug), however. REFM is currently providing a poor guidance, over-estimating the effect of the recent fast wind arrival, with recurrence currently a better guide.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Flux (top) and fluence (bottom)

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